

Final Draft
DOE BERYLLIUM INFORMATION SURVEY REPORT
(DOE Facility Experience from 1994 to 1996)

Introduction

This is a preliminary draft of the DOE Beryllium Information Survey Report. This draft version presents responses and data as they were submitted by the various survey participants without the benefit of follow up inquiries to clarify individual responses. Following the January forums, sites participating in the survey will be contacted for further clarification of some responses and for additional data and information if necessary. The Final Survey Report will reflect the clarifications and additional information provided by the survey participants. A list of survey participants is provided in **Table 1** of this document. As indicated in the title, this survey report reflects DOE experience from 1994 to 1996. Prior DOE beryllium-related experience was reported in a similar DOE Beryllium Information Survey prepared in 1994.

Executive Summary

Nine of the 15 sites surveyed (Allied Signal-Kansas City Plant, Fermilab, LLNL, LANL, ORNL, Pantex, Rocky Flats, SNL, and Y-12) reported having workers who are potentially exposed to beryllium. Ames, ANL, Hanford, K-25, LBNL, and Pinellas reported that no workers are exposed. Ten of the 15 sites surveyed (LANL, Y-12, Allied, LBNL, SNL, Rocky Flats, Fermilab, Pantex, Hanford, and ORNL) reported a total of 64 different operations/processes at their facilities that could give rise to beryllium exposure. These operations or processes ranged from common industrial activities such as machining (Allied, LLNL, LANL, SNL, Y-12), cleaning (Allied, LLNL, and Y-12), and welding (Allied), to more specialized operations such as D&D (LANL, Rocky Flats, and Y-12), research (Ames, Hanford, ORNL, and SNL), and various weapons maintenance, testing, and disposal activities (LLNL, Pantex, SNL, and Y-12).

Between 518 and 530 workers in 58 different job categories are potentially exposed to beryllium at the DOE sites surveyed. For those sites reporting potentially exposed workers, the numbers were as

follows: Allied, 28; Fermilab, several hundred; LANL, 48; ORNL, 51; Pantex, 70 to 82; Rocky Flats, approximately 100; SNL, 28; and Y-12, 158. The job categories in which the greatest number of employees were potentially exposed to beryllium were production technicians (Pantex: 42-52); machinists (Allied, LANL, SNL, and Y-12: 51); technicians (Fermilab, LANL, SNL, and Y-12: 42); repackaging workers (Rocky Flats: 40); researchers (LBNL, LANL, ORNL, and SNL: 36); D & D workers (Rocky Flats: 30); radiation protection technologists (Rocky Flats: 25); and welders (Allied: 22).

Allied and Rocky Flats have performed baseline exposure monitoring for each job category and operation. Y-12 and ORNL have not, but Y-12 indicated that at least one area sample was taken for each operation and ORNL provided personal breathing zone sampling data for two of their seven operations that present the potential for beryllium exposures. The remaining sites reported varying baseline monitoring strategies and statuses ranging from ANL, LLNL, LANL, Fermilab, and Hanford, who reported that exposure monitoring has or would be performed as necessary for operations that present the potential for exposure to beryllium, to Pantex and SNL, who indicated that baseline exposure monitoring has been performed for some operations or on personnel in certain job categories. DOE has adopted the Occupational Safety and Health Administration's (OSHA's) Permissible Exposure Limits (PELs) for beryllium as the allowable worker exposure limits within the Department. As defined in the applicable OSHA standard (29 CFR 1910.1000), these PELs are an 8-hour time weighted average (TWA) exposure limit of $2 \mu\text{g}/\text{m}^3$ (the average concentration of airborne beryllium that a worker may be exposed to during any 8-hour work shift of a 40-hour work week); a ceiling limit of $5 \mu\text{g}/\text{m}^3$ (the maximum concentration of airborne beryllium that a worker may be exposed to at any time during the 8-hour work shift except for a time period of 30 minutes during which the concentration may reach a maximum peak level referred to as the short-term exposure limit (STEL)); and a 30-minute STEL of $25 \mu\text{g}/\text{m}^3$ (the maximum peak airborne concentration of beryllium that a worker may be exposed to for periods not to exceed 30 minutes).

Allied, Fermilab, LANL, ORNL, Pantex, SNL, and Y-12 provided monitoring data for 56 operations or job categories. The highest 8-hour TWA exposure level ($25 \mu\text{g}/\text{m}^3$) related to these operations was reported at LANL and corresponded to the performance of powder operations. Three other operations/job categories (electroplating, Y-12; handling of beryllium, Fermilab; senior engineering assistant, Y-12) reported maximum 8-hour TWA exposure levels above $2 \mu\text{g}/\text{m}^3$; one (machining, SNL) reported maximum 8-hour TWA exposure levels between 1 and $2 \mu\text{g}/\text{m}^3$; and 13 reported maximum 8-hour TWA exposure levels between 0.1 and $1.0 \mu\text{g}/\text{m}^3$. The maximum 8-hour TWA exposure levels for the remaining operations/job categories were below $0.1 \mu\text{g}/\text{m}^3$. 30-minute short-term exposure samples were reported for 6 of the 56 operations/job categories. Such samples are used to determine compliance with the STEL and are typically collected during operations and time periods where worker exposures to airborne beryllium are expected to be at their highest levels. Reported results from this monitoring ranged from non-detectable to $105 \mu\text{g}/\text{m}^3$ (powder operations, LANL). Hanford, LLNL, and Rocky Flats reported site-wide exposure ranges without providing monitoring data for each operation or job category. Specifically, Hanford indicated that all beryllium area and personal samples were below $2 \mu\text{g}/\text{m}^3$ (8-hour TWA); LLNL indicated that all results were below the detection limit of the analytical method (ICP-MS); and Rocky Flats indicated that personal, 8-hour TWA samples were sometimes above the plant action level of $0.5 \mu\text{g}/\text{m}^3$, but below the OSHA TWA PEL of $2.0 \mu\text{g}/\text{m}^3$.

DOE-wide and Site-wide beryllium exposure profiles can be developed from the operation- and job category-specific 8-hour TWA personal breathing zone monitoring results provided by the sites. For instance, according to the survey respondents, 8-hour TWA personal exposure levels ranged from non-detectable to $25 \mu\text{g}/\text{m}^3$ on sites within the DOE complex. Of these sites, three (LANL, Pantex, and Y-12) reported maximum exposure levels above $2.0 \mu\text{g}/\text{m}^3$, and two (Allied and SNL) reported maximum exposures between 1.0 and $2.0 \mu\text{g}/\text{m}^3$. One site (Fermilab) reported maximum exposures, between 0.5

and $1.0 \mu\text{g}/\text{m}^3$, one site (ORNL) reported a maximum exposure of $0.45 \mu\text{g}/\text{m}^3$, and one site (LLNL) indicated that all sampling results were non-detectable.

Fermilab, LANL, and SNL indicated that short-term samples are typically collected over the full duration of the potential exposure period and that zero exposure is assumed for activities that do not involve beryllium or are outside the beryllium operations area. LANL indicated that additional samples are collected if there is potential for beryllium exposure before and/or after the short-term samples are taken and that all samples are used to calculate the 8-hour TWA exposure level. Pantex and Y-12 indicated that they collect 8-hour TWA samples in conjunction with the short-term samples, indicating that exposure levels during other periods of the work day are not assumed to be zero, but rather are measured.

Exposure limits used at the sites surveyed included varying combinations of the three OSHA PELs ($2 \mu\text{g}/\text{m}^3$ 8-hour TWA, $25 \mu\text{g}/\text{m}^3$ STEL, and $5 \mu\text{g}/\text{m}^3$ ceiling) as well as two site-specific surface contamination limits. Twelve of the 14 sites surveyed (Allied, Ames, ANL, Fermilab, Hanford, K-25, LLNL, LANL, Pantex, Rocky Flats, SNL, and Y-12) use the OSHA TWA PEL of $2 \mu\text{g}/\text{m}^3$ as their 8-hour TWA exposure limit. Six of the sites (Allied, Ames, ANL, LLNL, LANL, and Pantex) use the OSHA ceiling limit of $5 \mu\text{g}/\text{m}^3$ as their ceiling. Three of the sites (Ames, Pantex, and Y-12) use OSHA STEL of $25 \mu\text{g}/\text{m}^3$ as their 30 minute STEL. Two sites reported using the following surface contamination limit: $2 \mu\text{g}/100\text{cm}^2$ (Fermilab) and $1 \mu\text{g}/100\text{cm}^2$ (SNL). (Note: OSHA does not specify a limit for surface contamination.)

Action levels (the point at which protective measures such as training, medical surveillance, and area access restrictions are implemented) used at the sites ranged from none to $1 \mu\text{g}/\text{m}^3$ (8-hour TWA). Six sites (Allied, Ames, Fermilab, K-25, SNL, and Y-12) use $1 \mu\text{g}/\text{m}^3$ (8-hour TWA) as their action level; two sites (Pantex and Rocky Flats) use $0.5 \mu\text{g}/\text{m}^3$ (8-hour TWA); and three sites (ANL, Hanford, and

LANL) do not use action levels. Pantex also uses a surface contamination action level of 2.5 $\mu\text{g}/100\text{cm}^2$ for establishing regulated areas. LLNL does not use an action level but has an administrative warning range of 0.2 - 2.0 $\mu\text{g}/\text{m}^3$.

Forty-four of the 64 operations identified in this survey report the use of some kind of engineering control to reduce beryllium exposures. Some form of local exhaust ventilation (including laboratory hoods, fume hoods, and ventilated enclosures) is used for 23 of the 64 operations. Other controls include general room ventilation, HEPA vacuums, wet machining, remote operation, and various enclosures. Respirators are used regularly for 16 of the 64 operations and “sometimes” or “when action levels are reached” for 8 operations.

Allied, Fermilab, Hanford, K-25, LANL, Rocky Flats, SNL, and Y-12 reported controlling access to some (based on exposure potential) or all beryllium operations or work areas. LLNL and Pantex indicated that none of their current beryllium operations met their criteria for establishing controlled access areas. Access controls for established beryllium areas vary from site to site. Responders did, however, report the use of several common prerequisites necessary for entry into controlled beryllium areas. These prerequisites include proper training (Allied, Fermilab, LANL, and Pantex), proper authorization (Allied, LBNL, Rocky Flats, SNL, and Y-12), and a need to enter to perform assigned work duties (Fermilab, Hanford, LBNL, LANL, Rocky Flats, SNL, and Y-12).

Clean-up workers at LANL, Rocky Flats, and Y-12 are potentially exposed to beryllium during D&D operations. **Note:** Y-12 had only one D&D operation with the potential for beryllium exposure. At Rocky Flats, clean-up workers potentially exposed to beryllium “suit up” with full protective gear when they perform D&D operations. In Y-12's one D & D operation, personnel wore a full face respirator with HEPA filters, tyvek suits, gloves, and shoe covers. LANL employees conducting D&D operations are required to wear company provided modesty garments, coveralls, gloves, site-specific

shoes, and booties. Y-12 workers wore respirators during their one D&D operation. LANL and Rocky Flats determine the need for respiratory protection based on the potential for exposure.

Eleven of the sites surveyed (Allied, Ames, Fermilab, Hanford, LBNL, LLNL, LANL, Pantex, Rocky Flats, SNL, and Y-12) plan to use beryllium in future operations and/or processes; ANL does not. Operations that could give rise to beryllium exposure are expected to continue at Allied, Fermilab (at least the handling and storage operations), Hanford, LLNL, LANL, Pantex (all but the weapon dismantlement operations), Rocky Flats, SNL, and Y-12 (however, the future of two operations, applications and D & D, is unknown). Allied, Y-12, and SNL will use beryllium in all current operations. Ames will use it for a spectroscopic analysis operation, and a research operation involving the transmission of low energy. Fermilab will continue operations involving storage and bulk handling of metallic beryllium blocks. Hanford will use beryllium for research activities. LBNL will use it for materials science research. LLNL will use it in current operations and in the proposed contained firing facility and potentially in the National Ignition Facility. LANL will use it at the new Beryllium Technology Facility. Pantex's ongoing weapon programs and weapon components demilitarization and sanitization operations and Rocky Flats' repackaging of beryllium parts and D & D work will also continue to involve the potential for beryllium exposures.

Table 1.
DOE Facilities Contacted During the 1996 Beryllium Survey

1. Allied Signal, Kansas City Plant (Allied)
2. Ames Laboratory (Ames)
3. Argonne National Laboratory - East (ANL)
4. Fermilab
5. Hanford (joint response from Fluor Daniel Hanford and Pacific Northwest National Laboratory)
6. K-25, Oak Ridge (K-25)
7. Lawrence Berkeley National Laboratory (LBNL)
8. Lawrence Livermore National Laboratory (LLNL)
9. Los Alamos National Laboratory (LANL)
10. Oak Ridge National Laboratory (ORNL)
11. Pantex Plant
12. Pinellas Plant
13. Rocky Flats Plant
14. Sandia National Laboratories - New Mexico and California (SNL)
15. Y-12, Oak Ridge (Y-12)

- 1. Currently, are any workers at your facility potentially exposed to beryllium in the course of their work?**

Summary Response:

Nine of the 15 sites surveyed (Allied, Fermilab, LLNL, LANL , ORNL, Pantex, Rocky Flats, SNL, and Y-12) reported having workers who are potentially exposed to beryllium. Ames, ANL, Hanford, K-25, LBNL, and Pinellas reported that no workers are exposed.

Detailed Response:

"Yes" responses were given by Allied, Fermilab, LLNL, LANL, ORNL, Pantex, Rocky Flats, SNL, and Y-12. Several facilities supplemented their "yes" responses as follows:

Allied: The hazard is minimized because the copper-beryllium alloy used in the facility contains only two percent or less beryllium.

LLNL: Operations that present the potential for beryllium exposure are of short duration occurring on a sporadic basis a few times per year.

ORNL: No employees have ongoing, direct exposure to beryllium. Activities range from short-term experiments to movement of beryllium metal in primary storage and do not involve the potential for significant exposure.

Rocky Flats: Most workers exposed to beryllium are involved in hazardous waste work. Other Rocky Flats workers may have incidental exposures from discontinued operations in various buildings, however, airborne concentrations of beryllium in these buildings is believed to be below detection limits.

"No" responses were given by Ames, ANL, Hanford, K-25, LBNL, and Pinellas. Several facilities supplemented their "no" responses as follows:

Ames: Ames has two research operations: one where a beryllium solution (<1000 ppm) is used as a standard in spectroscopic analysis, and another where beryllium is a component of X-ray tube windows in an operation involving low energy transmission. Ames characterizes the potential for beryllium exposure in both operations as negligible.

ANL: Any beryllium work would be [handled] as a “special case,” and reviewed on an individual basis. ANL provided no further clarification regarding the nature or frequency of "special case" beryllium operations.

Hanford: PNNL conducts limited research activities involving small quantities of beryllium in solution.

K-25: Although the K-725 facility is contaminated with small quantities of beryllium, no personnel are exposed to it because the facility is unoccupied, shut down, and access is controlled, and beryllium contamination within the facility is contained in sealed, inoperable ventilation systems.

LBNL: LBNL has one operation where a researcher may have to cut small pieces of beryllium foil. Researchers prevent skin exposure during this operation through the use of gloves.

2. What are the operations/processes that give rise to these exposures?

Summary Response:

Ten of the 15 sites surveyed (Allied, Fermilab, Hanford, LANL, LBNL, ORNL, Pantex, Rocky Flats, SNL, and Y-12) reported a total of 64 different operations/processes at their facilities that could give rise to beryllium exposure. These operations or processes ranged from common industrial activities such as machining (Allied, LLNL, LANL, SNL, and Y-12), cleaning (Allied, LLNL, and Y-12), and welding (Allied), to more specialized operations such as D&D (LANL, Rocky Flats, and Y-12), research (Ames, Hanford, ORNL, and SNL), and various weapons maintenance, testing, and disposal activities (LLNL, Pantex, SNL, and Y-12).

Detailed Response:

“None” responses were provided by ANL, K-25, and Pinellas. ANL supplemented their negative response indicating that they had occasional minor work with beryllium alloys. ANL provided no further detail regarding the nature of this “minor work.”

Table 2 shows the DOE operations and processes that use beryllium as well as the facilities where these operations and processes occur.

Table 2.
Facilities with Current or Prior Beryllium Use (by Operation/Process/Equipment)

| Operation/ Process/ Equipment | Facility |
|--|-------------------------|
| Alloy Development | LANL |
| Applications | Y-12 |
| Baghouse | Y-12 |
| Beryllium Sputtering | LLNL |
| Changing Filters | LLNL, Y-12 |
| Chemical Technology | ORNL |
| Cleaning, Machine | Y-12 |
| Cleaning, Parts | Y-12 |
| Cleaning and Plating | Allied |
| Cleanup of Detonated Shells | LLNL |
| Clothes Laundering | LANL |
| Custodial work | LANL |
| Cutting Beryllium Foil | LBNL |
| Cutting/Grinding/Polishing | SNL |
| Deburring | Allied |
| D & D | Rocky Flats, Y-12, LANL |

| Operation/ Process/ Equipment | Facility |
|---|--------------------------------|
| Detonation of Shells | LLNL |
| Development | Y-12 |
| Electrical Applications Using Cu/Be Conductors (handling, shearing, heat curing) | Fermilab |
| Electron Beam Welding | LLNL |
| Engineering Technology | ORNL |
| Hand-Sawing Beryllium Pipe (single occurrence operation) | Fermilab |
| Handling Beryllium Blocks | Fermilab |
| Handling Wastes | LLNL |
| Inspection | Y-12 |
| Industrial Hygiene Sampling | LANL |
| Ion Implant, Bead Blasting, Metallization | SNL |
| Joining and Coating | LANL |
| Laboratory | Y-12 |
| Laser Machining | LLNL |
| Machining | Allied, LLNL, LANL, SNL, Y-12, |
| Maintenance (contaminated drains and vacuum lines) | LLNL |
| Mechanical Properties | Y-12 |
| Metallography | LANL |
| Metallurgical Stress Studies | LLNL |
| Physics | ORNL |
| Pit Cleaning | Pantex |

| Operation/ Process/ Equipment | Facility |
|---|-----------------|
| Plant and Equipment | ORNL |
| Powder Operations | LANL |
| Preventive Maintenance | LANL |
| Quality Evaluation | Y-12 |
| Radiation Screening | LANL |
| Research - Beryllium Solutions | Hanford (PNNL) |
| Research - Deposition of Gases onto a Substrate | SNL |
| Research - Human Sciences | ORNL |
| Research - Reactors | ORNL |
| Research - Transmission of Low Energy (x-ray) | Ames |
| Respirator Decontamination | LANL |
| Spectroscopic Analysis | Ames |
| Solid State | ORNL |
| Storage of Beryllium Blocks | Fermilab |
| Washing/Moving of Gravel from Shot Tables | LLNL |
| Waste Reclamation | Allied |
| Weapon Assembly/Disassembly | Pantex, SNL |
| Weapon Components Separation | Pantex |
| Weapon Components Crushing | Pantex |
| Weapon Components Shredding | Pantex |
| Weapon Components Detonation | Pantex |
| Weapon Dismantlement | LLNL, Pantex |
| Weapon Dismantlement/ Disassembly | Pantex |

| Operation/ Process/ Equipment | Facility |
|--|-----------------|
| Weapon Integrity Testing | LLNL |
| Weapon Shield Installation and Removal | Pantex |
| Weapons Material Management | Y-12 |
| Welding | Allied |

3. What is the total number of workers estimated to be exposed to beryllium at your facility?

Summary Response:

For those sites reporting potentially exposed workers, the numbers were as follows: Allied, 28; Fermilab, several hundred; LANL, 48; ORNL, 51; Pantex, 70 to 82; Rocky Flats, approximately 100; SNL, 28; and Y-12, 158.

Detailed Response:

Table 3 lists the total estimated number of workers potentially exposed to beryllium for each facility.

Table 3.

Total Estimated Number of Workers Potentially Exposed to Beryllium

| Facility | Estimated Number of Workers Potentially Exposed to Beryllium |
|-----------------|---|
| Allied | 28 |
| Ames | None |
| ANL | None |

| Facility | Estimated Number of Workers Potentially Exposed to Beryllium |
|-------------|--|
| Fermilab | Several hundred workers |
| Hanford | None |
| K-25 | None |
| LLNL | None |
| LBNL | None |
| LANL | 48 (more employees are on LANL's Beryllium Worker Surveillance Program; however, many of these employees no longer work with beryllium) |
| ORNL | 51 |
| Pantex | 70-82 |
| Pinellas | None |
| Rocky Flats | Approximately 100 |
| SNL | 28 |
| Y-12 | 158 (equal to the number of employees in the Active Beryllium Medical Surveillance Program) |

4. & 5. What are the job categories/titles of the workers exposed to beryllium? How many workers are exposed in each category.

Summary Response:

Between 518 and 530 workers in 58 different job categories are potentially exposed to beryllium at the DOE sites surveyed. The job categories in which the greatest number of employees were potentially exposed to beryllium were production technicians (Pantex: 42-52); machinists (Allied, LANL, SNL, and Y-12: 51); technicians (Fermilab, LANL, SNL, and Y-12: 42); repackaging workers (Rocky Flats: 40); researchers (LBNL, LANL, ORNL, and SNL: 36); D & D workers (Rocky Flats: 30); radiation protection technologists (Rocky Flats: 25); and welders (Allied: 22).

Detailed Response:

”**Not applicable**” responses were provided by Ames, ANL, Hanford, K-25, LBNL, and Pinellas.

Table 4 lists the job categories and number of potentially exposed workers for the remaining facilities.

Table 4.**Number of Potentially Exposed Workers by Facility and Job Category**

| Job Category | Facility | Total in Facility | Total in Job Category |
|---|-----------------|--------------------------|------------------------------|
| Air Conditioning and Refrigeration Mechanic | Y-12 | 1 | 1 |
| Assembly Person | Y-12 | 11 | 11 |
| Chemical Material Handler | Allied | 6 | 6 |
| Cleaner | Y-12 | 2 | 2 |
| Custodian | LANL | 3 | 3 |
| Development Engineer | Y-12 | 4 | 4 |
| D & D Worker | Rocky Flats | 30 | 30 |
| Electrician | Y-12 | 15 | 15 |
| Engineer | SNL | 4 | |
| | Y-12 | 1 | 5 |
| Engineering technician | Pantex | 8 | 8 |
| Environment Safety and Health Personnel | Fermilab | Unknown ¹ | Unknown ¹ |
| Electrician | LANL | 2 | 2 |
| Electroplater | Y-12 | 2 | 2 |
| Experimenters | Fermilab | Unknown ¹ | Unknown ¹ |
| Fitters | LANL | 3 | 3 |
| Hazardous Waste Technician | LLNL | 3 | 3 |
| Health and Safety Technician | LLNL | 2 | 2 |
| Industrial Hygiene Technician | LANL | 2 | 2 |
| Industrial Hygienist | LANL | 3 | 3 |

| Job Category | Facility | Total in Facility | Total in Job Category |
|-----------------------------|-----------------|--------------------------|------------------------------|
| Insulator | Y-12 | 7 | 7 |
| Lab Supervisor | Y-12 | 1 | 1 |
| Lab Technician | ORNL | 2 | 13 |
| | Y-12 | 11 | |
| Laborer | LANL | 3 | 3 |
| Machinist | Allied | 5 | 51 |
| | LANL | 6 | |
| | SNL | 9 | |
| | Y-12 | 31 | |
| Maintenance Mechanic | LLNL | 5 | 5 |
| Materials Clerk | Y-12 | 2 | 2 |
| Mechanical Technician | LLNL | 7 | 7 |
| Metallographist | LANL | 4 | 4 |
| Millwright | ORNL | 8 | 8 |
| Office Clerical | Y-12 | 2 | 2 |
| Operations Supervisor | Pantex | 13-15 | 13-15 |
| Operations Support Engineer | Y-12 | 5 | 5 |
| Outside Machinist | Y-12 | 3 | 3 |
| Painter | LANL | 2 | 2 |
| Pipefitter | Y-12 | 5 | 5 |
| Plater | Allied | 10 | 10 |
| Procurement | ORNL | 1 | 1 |

| Job Category | Facility | Total in Facility | Total in Job Category |
|---------------------------------------|---|---|------------------------------|
| Production Fabricator | Allied | 5 | 5 |
| Production Technician | Pantex | 42-52 | 42-52 |
| Radiation Control Technician | LANL | 2 | 2 |
| Radiation Protection Technologist | Rocky Flats | 25 | 25 |
| Reactor Controller | ORNL | 3 | 3 |
| Reactor Supervisor | ORNL | 1 | 1 |
| Repackaging Worker | Rocky Flats | 40 | 40 |
| R&D Group Leader | Y-12 | 1 | 1 |
| Researcher | LBNL LANL ORNL SNL | 0 (workers cut foil, skin exposure prevented through glove use) 4 30 2 | 36 |
| Riggers | ORNL | 2 | 2 |
| Scientist (Generic) | LLNL | 3 | 3 |
| Service Operations Support Specialist | Y-12 | 2 | 2 |
| Sheet Metal Worker | ORNL | 4 | 4 |
| Shop Maintenance Personnel | Y-12 | 2 | 2 |
| Supervisor, hourly personnel | Y-12 | 15 | 15 |

| Job Category | Facility | Total in Facility | Total in Job Category |
|---|----------|----------------------|----------------------------|
| Technical Support | Y-12 | 14 | 14 |
| Technical Support Supervisor | Y-12 | 2 | 2 |
| Technician | Fermilab | Unknown ¹ | 42 (not including unknown) |
| | LANL | 12 | |
| | SNL | 13 | |
| | Y-12 | 17 | |
| Tinner | LANL | 3 | 3 |
| Truck Driver | Y-12 | 1 | 1 |
| Weapon Engineer | Pantex | 7 | 7 |
| Welder | Allied | 2 | 22 |
| TOTAL (not including “unknowns”) | | | 518 - 530 |

1. Fermilab qualified their "unknown" response for the number of workers potentially exposed in each category by indicating that records were not maintained for activities that involved negligible exposures.

6. Was baseline monitoring performed for each job category and operation.

Summary Response:

Allied and Rocky Flats have performed baseline monitoring for each job category and operation. Y-12 and ORNL have not; however, Y-12 indicated that at least one area sample was taken for each operation and ORNL provided personal breathing zone sampling data for two of their seven operations that present the potential for beryllium exposures. The remaining sites reported varying baseline monitoring strategies and statuses ranging from ANL, LLNL, LANL, Fermilab, and Hanford, who reported that monitoring has or would be performed as

necessary for operations that present the potential for exposures, to Pantex and SNL, who indicated that baseline monitoring has been performed for some operations or on personnel in certain job categories.

Detailed Response:

"Yes" responses were submitted by Allied and Rocky Flats.

"No" responses were submitted by Y-12 and ORNL. Y-12 qualified their "no" response indicating that at least one area sample was taken for each operation. ORNL indicated that current operations were infrequent and involved relatively insignificant exposure potentials. ORNL further noted that baseline monitoring would be performed for any future activities involving beryllium that might present the potential for exposure.

"Not applicable" responses were submitted or implied by Ames, K-25, LBNL, and Pinellas.

The remaining facilities reported varying baseline monitoring strategies or statuses.

ANL: Indicated that monitoring would be performed for operations that presented the potential for exposures.

Fermilab: Indicated that baseline monitoring was performed "as necessary to characterize exposures not known to be negligible from previous sampling."

Hanford: Indicated that exposure monitoring is conducted as needed to quantify beryllium levels.

LLNL: Indicated that baseline monitoring was performed only for those jobs that were considered a potential exposure source by the responsible industrial hygienist.

LANL: Indicated that baseline monitoring has been conducted for operations where there is a potential for airborne beryllium particulate. Baseline monitoring has not been conducted, however, for some operations such as nondestructive inspection of parts and heat treating samples enclosed in glass ampules where there is limited or no potential to exceed the detection limit of the analytical method.

Pantex: Indicated that they generally only perform personal monitoring on individuals in technician related job categories and consider exposures to personnel in supervisor or engineer job categories to be equal to (or less than) that of the technicians. Pantex also indicated that baseline monitoring is ongoing for the pit cleaning and demilitarization operations and is performed on all new weapons program operations where there is a potential for worker exposure to beryllium. Pantex did not perform baseline monitoring on weapons program operations that were started prior to 1995.

SNL: Indicated that baseline monitoring had been performed for the bead blasting, ion implant, metallization, and machining operations; that “wipe samples only” had been collected for the cutting/grinding/polishing operation; and that no monitoring had been performed for the weapon assembly/disassembly and research operations.

7., 8., & 9. What were the beryllium exposure levels for each job category and operation, without regard to respiratory protection? Are these area or personal samples? What is the sampling duration (i.e., short-term or 8-hour TWA)?

Summary Response:

Allied, Fermilab, LANL, ORNL, Pantex, SNL, and Y-12 provided monitoring data for 56 operations or job categories. The highest 8-hour TWA exposure level ($25 \mu\text{g}/\text{m}^3$) related to these operations was reported at LANL and corresponded to the performance of powder operations. Three other operations/job categories (electroplating, Y-12; handling of beryllium, Fermilab; senior engineering assistant, Y-12) reported maximum 8-hour TWA exposure levels above $2 \mu\text{g}/\text{m}^3$; one (machining, SNL) reported maximum 8-hour TWA exposure levels between 1 and $2 \mu\text{g}/\text{m}^3$; and 13 reported maximum 8-hour TWA exposure levels between 0.1 and $1.0 \mu\text{g}/\text{m}^3$. The maximum 8-hour TWA exposure levels for the remaining operations/job

categories were below $0.1 \mu\text{g}/\text{m}^3$. 30-minute short-term exposure samples were reported for 6 of the 56 operations/job categories. Note, LANL used the expression “30 minute ceiling samples” in their survey, however, because the sampling period matched that for determining short-term exposure levels, survey compilers interpreted these data as 30-minute short-term exposure samples. Reported survey results ranged between non-detectable to $105 \mu\text{g}/\text{m}^3$ (powder operations, LANL). Hanford, LLNL, and Rocky Flats reported site-wide exposure ranges without providing monitoring data for each operation or job category. Specifically, Hanford indicated that all beryllium area and personal samples were below $2 \mu\text{g}/\text{m}^3$ (8-hour TWA); LLNL indicated that all results were below the detection limit of the analytical method (ICP-MS); and Rocky Flats indicated that personal, 8-hour TWA samples were sometimes above the plant action level of $0.5 \mu\text{g}/\text{m}^3$, but below the PEL of $2.0 \mu\text{g}/\text{m}^3$.

Detailed Response:

Allied reported monitoring results by job category; **Fermilab** and **SNL** reported monitoring results by operation or process; **Pantex** reported monitoring results by operation or process and for a few processes indicated job categories of those sampled; and **LANL**, **ORNL**, and **Y-12** reported monitoring results by both job category and operation or process. **Table 5** summarizes monitoring data provided by Allied, Fermilab, LANL, Pantex, SNL, and Y-12.

Other responses included:

Hanford: Indicated that the results of all beryllium monitoring were below the American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values (TLVs) ($2 \mu\text{g}/\text{m}^3$, 8-hour TWA). Hanford indicated that these were both personal and area samples. Hanford provided no further clarification regarding the operations or personnel monitored, the specific monitoring results, or the sampling duration.

LLNL: Indicated that all monitoring results were less than the detection limit of the analytical method (ICP-MS). These samples were personal samples taken over “the duration of the operation - usually 1 hour or less.”

Rocky Flats: Indicated that personal 8-hour TWA sample resultss were sometimes above the plant standard of 0.5 µg/m³, but below the PEL of 2.0 µg/m³.

"Not applicable" responses were submitted by Ames, ANL, K-25, LBNL, and Pinellas.

Table 5.

Beryllium Monitoring Results for Job Categories and Operations or Processes

| Operation/Process or Job Category | Facility | Monitoring Results (µg/m ³) Reported as: | | | Personal or Area Sample |
|--------------------------------------|-------------------|---|------------------------------|--------------------|-------------------------|
| | | 8-hour TWA | 30 min. Short-term Exposures | Other ¹ | |
| Alloy Development | LANL | 0.09 (max) | | | personal |
| Applications | Y-12 ² | | | ND - 11.3 | personal |
| Assembly Persons | Y-12 ² | ND | | | personal |
| Baghouse | Y-12 ² | | | ND | personal |
| Chemical Material Handler | Allied | | | <0.24 - 0.34 | both |
| Chemical Technology (Lab Technician) | ORNL | 0.096 - 0.45 | | | personal |
| Changing Filters | Y-12 ² | | | ND | personal |
| Chemical Operator | Y-12 ² | 0.2 - 0.6 | | | personal |
| Chemist, Supervisor | Y-12 ² | ND | | | personal |
| Cleaner | Y-12 ² | ND | | | personal |
| Cleaning, Machine | Y-12 ² | | | ND | personal |
| Cleaning, Parts | Y-12 ² | | | ND | personal |
| Custodian | LANL | <0.002 | | | personal |
| D & D | Y-12 ² | | | ND | personal |

| Operation/Process or Job Category | Facility | Monitoring Results (µg/m ³) Reported as: | | | Personal or Area Sample |
|--|------------------------|---|------------------------------|----------------------------------|-------------------------|
| | | 8-hour TWA | 30 min. Short-term Exposures | Other ¹ | |
| Development | Y-12 ² | | | ND - 8.9 | personal |
| Electricians | LANL | <0.002 | | | personal |
| | Y-12 ² | ND | | | personal |
| Electroplater | Y-12 ² | ND - 11.3 | | | personal |
| Engineering | Y-12 ² | ND | | | personal |
| Facilities Maintenance (specific craft unknown) | Y-12 ² | ND | | | personal |
| Filter Service Person | Y-12 ² | ND | | | personal |
| Fitters | LANL | <0.002 | | | personal |
| Hand-Sawing Beryllium Pipe (single occurrence operation) | Fermi-lab ³ | ND (<0.05) | | ND (< 0.45) | personal |
| | | | | 0.93 | area |
| Handling of Beryllium Blocks | Fermi-lab ³ | ND (<0.1) - 4.8 | | ND (<0.1) - 0.6 | personal |
| | | | | ND (<0.1) - 0.9 | area |
| Heat Curing Cu/Be Conductors | Fermi-lab ³ | ND (<0.2) | | ND (<0.18) | personal |
| | | | | ND (<0.18) | area |
| Industrial Hygiene Sampling (powder operation sampling) | LANL | 0.43 | | | personal |
| Inspection | Y-12 ² | | | ND | personal |
| Ion Implant, Bead Blasting, Metallization | SNL | below limit of quantitation | below limit of quantitation | | personal |
| Joining/Coating | LANL | 0.13 (max) | | | personal |
| Lab Technician | Y-12 ² | ND[21 samples] 0.1 [1 sample] | | | personal |
| Laboratory | Y-12 ² | | | ND[29 samples] 0.1 [1 sample] | personal |
| Laborers | LANL | <0.002 | | | personal |

| Operation/Process or Job Category | Facility | Monitoring Results ($\mu\text{g}/\text{m}^3$) Reported as: | | | Personal or Area Sample |
|-----------------------------------|------------------------|---|------------------------------|----------------------------------|-----------------------------|
| | | 8-hour TWA | 30 min. Short-term Exposures | Other ¹ | |
| | Y-12 ² | ND | | | personal |
| Machining | LANL | 95 % <0.02 (>1000 samples collected) | | | 50 % personal/ 50 % area |
| | SNL | <1.2 | | | personal |
| | Y-12 ² | | | ND[17 samples] 0.1 [1 sample] | personal |
| Machinist | Allied | | | <0.04 - <2.0 | both |
| | Y-12 ² | ND[59 samples] 0.1 [1 sample] | | | personal |
| Materials Clerk | Y-12 ² | ND | | | personal |
| Mechanical Properties | Y-12 ² | | | ND | personal |
| Outside Machinist | Y-12 ² | | ND | | personal |
| Pit Cleaning | Pantex | <0.16 | | | personal |
| Plant and Equipment | ORNL | <0.028 | | | personal |
| Plater | Allied | | | <0.006 - <0.01 | area |
| Powder Operations | LANL | 3.6 - 25 | | | personal |
| | | | 5.7 - 105 ⁵ | | personal |
| Production Fabricator | Allied | | | 0.01 - 0.02 | both |
| Quality (specific craft unknown) | Y-12 ² | ND | | | personal |
| Quality Evaluation | Y-12 ² | | | ND | personal |
| Respirator Decontamination | LANL | <0.006 (max) | | | personal |
| Security Inspector | Y-12 ² | ND | | | personal |
| Senior Engineering Assistant | Y-12 ² | ND - 8.9 | 0.4 and 3.6 | | personal |
| Storage of Beryllium Blocks | Fermi-lab ³ | | | ND (<0.3 - <5.0) | area |

| Operation/Process or Job Category | Facility | Monitoring Results ($\mu\text{g}/\text{m}^3$) Reported as: | | | Personal or Area Sample |
|--|-------------------|--|------------------------------|--------------------|-------------------------|
| | | 8-hour TWA | 30 min. Short-term Exposures | Other ¹ | |
| Technical Support | Y-12 ² | ND | | | personal |
| Tinners | LANL | <0.002 | | | personal |
| Weapon Assembly/ Disassembly | Pantex | <0.01 - <0.15 | | | personal |
| Weapon Components Separation (production technicians) | Pantex | ND - 0.8 | | | personal |
| | | | | <0.61 | area |
| Weapon Components Crushing (engineering technicians) | Pantex | <0.08 | | | personal |
| Weapon Components Shredding (engineering technicians) | Pantex | ND - 0.84 | | | personal |
| Weapon Components Detonation (engineering technicians) | Pantex | <0.11 | | | personal |
| | | | | ND - 2.1 | area |
| Weapon Dismantlement | Pantex | most 0.2 - 0.3 w/ high of 0.39 | | | personal |
| | | | <1.9 ⁴ | | personal |
| | | | | <1.9 | area |
| Weapon Dismantlement/ Disassembly | Pantex | <0.08 - <0.15 | | | personal |
| | | | <0.9 - <2.8 ⁴ | | personal |
| | | | | <0.4 - <0.6 | area |
| Weapon Shield Installation | Pantex | monitoring performed but results not available at the time of the survey | | | |
| Weapons Material Management | Y-12 ² | | | ND | personal |
| Welder | Allied | | | <0.01 - 0.4 | both |

ND = Nondetectable. Where survey response included the limit of detection, this limit is specified in parenthesis after the “ND”.

1. The sampling results listed in the “other” column were reported as follows:
 - Allied:** Sampling duration reported to be between 3 and 8 hours in most cases. Results were not identified as 8-hour TWA exposure levels.
 - Fermilab:** Sampling duration not specified. Note, Fermilab personal sampling results listed in the “other” column are the sampling results for the actual sampling time that correspond to the exposure levels reported in the “8-hour TWA” column. Fermilab assumes zero exposure for the remainder of the 8-hour work shift when calculating the 8-hour TWA exposure level.
 - LANL:** Result reported as a ceiling sample (30 minute duration).
 - Pantex:** Sampling duration not specified.
 - Y-12:** For data relating to operations or processes, Y-12 indicated that results were either 8-hour TWA or short-term exposure levels but did not distinguish between the two.
2. Note, **Y-12's** response provides additional detail regarding monitoring results (i.e., number of persons sampled, number of samples taken, and all sample results).
3. Fermilab indicated that most beryllium samples were collected over the duration of the operation, which was normally less than eight hours. Fermilab reported all personal sample results as “time weighted results.” Survey compilers interpreted these results as 8-hour TWA results.
4. **Pantex** reports a sampling duration of 30 - 45 minutes for short-term exposure monitoring.
5. LANL described these results as ceiling samples taken over 30 minute periods when an operation involved potential for highest exposures. Survey compilers interpreted these results as 30-minute short-term exposure levels.

10. What is the level of airborne beryllium concentration from short-term and/or 8-hour TWA monitoring?

Summary Response:

Sites providing 8-hour TWA personal breathing zone monitoring results reported exposure levels from non-detectable to 25 $\mu\text{g}/\text{m}^3$. Of these sites, three (LANL, Pantex, and Y-12) reported maximum exposure levels above 2.0 $\mu\text{g}/\text{m}^3$, and two (Allied and SNL) reported maximum exposures between 1.0 and 2.0 $\mu\text{g}/\text{m}^3$. One site (Fermilab) reported maximum exposures between 0.5 and 1.0 $\mu\text{g}/\text{m}^3$, one site (ORNL) reported a maximum exposure of 0.45 $\mu\text{g}/\text{m}^3$, and one site (LLNL) indicated that all sampling results were non-detectable.

Detailed Response:

Table 5 summarizes short-term and 8-hour TWA monitoring data by job category and operation or process for each facility. **Table 6** summarizes the range of beryllium exposure levels for a variety of operations or processes reported at each facility. Note, unless otherwise indicated in the footnotes of the table, Table 6 reflects personal sampling results reported as 8-hour TWA exposure levels (actual sampling durations may vary).

"**Not applicable**" responses were submitted or implied by Ames, ANL, K-25, LBNL, and Pinellas.

Other responses:

Hanford: Indicated that all monitoring results (both area and personal samples) were below $2 \mu\text{g}/\text{m}^3$. Hanford provided no further detail regarding monitoring results and did not specify whether or not the results represented 8-hour TWA exposure levels.

Rocky Flats: Indicated that the range of airborne beryllium concentrations vary from below the Rocky Flats action level ($0.5 \mu\text{g}/\text{m}^3$) to the PEL. Rocky Flats provided no further detail regarding actual monitoring results

Table 6.
Beryllium Exposure Levels
Personal Breathing Zone Samples, 8-hour TWAs

| Facility | Exposure Level in $\mu\text{g}/\text{m}^3$ | | | | | | | | | | |
|---------------------|--|--------|---------------|--------------|--------------|-------------|------------|------------|------------|------------|------------|
| | <Detection limit | <0.002 | 0.002 - <0.01 | 0.01 - <0.02 | 0.02 - <0.05 | 0.05 - <0.1 | 0.1 - <0.2 | 0.2 - <0.5 | 0.5 - <1.0 | 1.0 - <2.0 | ≥ 2.0 |
| Allied ¹ | | | X | X | X | X | X | X | X | X | |
| Fermilab | X (<0.05 - <0.2) | | | | | | X | X | X | | |
| LLNL ² | X | | | | | | | | | | |
| LANL | | X | X | X | | X | X | X | | | X |
| ORNL | | | | | X | X | X | X | | | |
| Pantex ³ | X | X | X | X | X | X | X | X | X | X | X |
| SNL ³ | X ⁴ | | | | | | | | | X | |
| Y-12 | X | | | | X | | X | X | X | X | X |

1. Allied responses reflect both personal and area samples with sampling durations that were typically between 3 and 8 hours.
2. LLNL indicated that samples were taken over “the duration of the operation - usually less than one hour.”
3. Pantex and SNL responses to questions 7 and 10 reported different exposure levels for the same operations without providing further clarification regarding the differences. This table reports a compilation of the Pantex and SNL responses to questions 7 and 10.
4. Includes both “nondetectable” and “below the limit of quantitation” responses.

11. If short-term samples were taken, what is the beryllium exposure for the remainder of the work shift?

Summary Response:

Fermilab, LANL, and SNL indicated that short-term samples are typically collected over the full duration of the potential exposure period and that zero exposure is assumed for activities that do not involve beryllium or are outside the beryllium operations area. LANL indicated that additional samples are collected if there is potential for beryllium exposure before and/or after the short-term samples are taken and that all samples are used to calculate the 8-hour TWA exposure level. Pantex and Y-12 indicated that they collect 8-hour TWA samples in conjunction with their short-term samples, indicating that exposure levels during other periods of the work day are not assumed to be zero, but rather are measured.

Detailed Response:

Fermilab and LANL indicated that samples are typically collected for the duration of potential exposure periods, (i.e., Fermilab assumes zero exposure for the remainder of the work shift, LANL assumes zero exposure for activities that do not involve beryllium and are outside the Beryllium operations area). LANL stated that for operations where short-term samples are taken and there is a potential for beryllium exposure before and/or after the short-term samples are taken, additional samples are collected. All samples collected for an individual in a day are used to calculate the 8-hour TWA.

Hanford's response did not address the question.

Pantex and Y-12 took 8 hour TWA samples in conjunction with the short-term samples. The results are reported in **Table 7**.

SNL indicated that for operations that short-term samples were taken, exposures during the remainder of the work shift are zero.

"**Not applicable**" responses were submitted or implied by Allied (no short-term samples taken), Ames, ANL, K-25, LBNL, LLNL, ORNL (no short-term samples were reported), Rocky Flats, and Pinellas.

Table 7.
Beryllium Sampling Results -- Short-Term
and Corresponding 8-hour TWA Exposure Levels

| Facility | Operation or Job Category | 30 Minute Short-term level ($\mu\text{g}/\text{m}^3$) | 8-Hour TWA ($\mu\text{g}/\text{m}^3$) Measured over the Same Work shift |
|----------|--------------------------------------|---|---|
| Pantex | Weapon dismantlement | $<1.9^1$ $<1.9^1$ | 0.2 - 0.3 0.34-1.25 |
| Pantex | Weapon dismantlement/ disassembly | <0.9 - $<2.8^1$ <0.9 - $<2.8^1$ | <0.08 - <0.15 <0.36 - <2.6 |
| Y-12 | Senior engineering assistant | 3.6 0.4 | 0.4 0.02 |

1. Pantex reports a 30 - 45 minute sampling duration for short-term exposure monitoring.

12. & 13. What beryllium exposure limits are used at your facility? What is the action level currently being used at your facility?

Summary Response:

Exposure limits used at the sites surveyed included varying combinations of the three OSHA PELs ($2 \mu\text{g}/\text{m}^3$ 8-hour TWA, $25 \mu\text{g}/\text{m}^3$ 30-minute STEL, and $5 \mu\text{g}/\text{m}^3$ ceiling) as well as two site-specific surface contamination limits. Twelve of the 15 sites surveyed (Allied, Ames, ANL, Fermilab, Hanford, K-25, LLNL, LANL, Pantex, Rocky Flats, SNL, and Y-12) use the OSHA PEL of $2 \mu\text{g}/\text{m}^3$ as their 8-hour TWA exposure limit. Six of the sites (Allied, Ames, ANL, LLNL, LANL, and Pantex) use the OSHA ceiling limit of $5 \mu\text{g}/\text{m}^3$ as their ceiling. Three of the sites (Ames, Pantex, and Y-12) use the OSHA STEL of $25 \mu\text{g}/\text{m}^3$ as their 30 minute STEL. Two sites reported using the following surface contamination limit: $2 \mu\text{g}/100\text{cm}^2$ (Fermilab) and $1 \mu\text{g}/100\text{cm}^2$ (SNL).

Action levels used at the sites surveyed ranged from none to 1 $\mu\text{g}/\text{m}^3$ (8-hour TWA). Six sites (Allied, Ames, Fermilab, K-25, SNL, and Y-12) use 1 $\mu\text{g}/\text{m}^3$ (8-hour TWA) as their action level; two sites (Pantex and Rocky Flats) use 0.5 $\mu\text{g}/\text{m}^3$ (8-hour TWA); and three sites (ANL, Hanford, and LANL) do not use action levels. Pantex also uses a surface contamination action level of 2.5 $\mu\text{g}/100\text{cm}^2$ for establishing regulated areas. LLNL does not use an action level but has an administrative warning range of 0.2 - 2.0 $\mu\text{g}/\text{m}^3$. LBNL and ORNL did not respond to this question, and Pinellas responded "not applicable."

Detailed Response:

LBNL and ORNL did not respond to questions 12 and 13, and Pinellas responded "**not applicable.**" **Table 8** lists exposure limits and action levels used at each facility.

Table 8.
Beryllium Exposure Limits and Action Levels

| Facility | Exposure Limits | | | | | Action Levels (8-Hour TWA) | | | |
|-------------|----------------------------|----------------------------|-----------------------------|----------------------------------|--------------------------------|------------------------------|----------------------------|----------------|--------------------|
| | 8 hr TWA | Ceil- ing | 30 m STEL | Surface Contam- ination Limit | | 0.5 $\mu\text{g}/\text{m}^3$ | 1 $\mu\text{g}/\text{m}^3$ | none | other ¹ |
| | 2 $\mu\text{g}/\text{m}^3$ | 5 $\mu\text{g}/\text{m}^3$ | 25 $\mu\text{g}/\text{m}^3$ | 1 $\mu\text{g}/100\text{cm}^2$ | 2 $\mu\text{g}/100\text{cm}^2$ | | | | |
| Allied | X | X | | | | | X | | |
| Ames | X | X | X | | | | X | | |
| ANL | X | X | | | | | | X | |
| Fermilab | X | | | | X | | X | | |
| Hanford | X | | | | | | | X | |
| K-25 | X | | | | | | X | | |
| LLNL | X | X | | | | | | | X |
| LANL | X | X | | | | | | X ² | |
| Pantex | X | X | X | | | X ³ | | | |
| Rocky Flats | X | | | | | X | | | |

| Facility | Exposure Limits | | | | | Action Levels (8-Hour TWA) | | | |
|----------|-------------------------|-------------------------|--------------------------|----------------------------------|-----------------------------|----------------------------|-------------------------|------|--------------------|
| | 8 hr TWA | Ceil- ing | 30 m STEL | Surface Contam- ination Limit | | 0.5µg/ m ³ | 1 µg/ m ³ | none | other ¹ |
| | 2 µg/ m ³ | 5 µg/ m ³ | 25 µg/ m ³ | 1 µg/ 100cm ² | 2 µg/ 100cm ² | | | | |
| SNL | X | | | X | | | X | | |
| Y-12 | X | | X | | | | X | | |

1. **LLNL** does not use an action level but does have an administrative warning range of 0.2 - 2.0 µg/m³ which requires investigation.
2. **LANL** supplemented their “none” response indicating that action is taken based on the results of the sampling and the potential for variability of the operation and worker practices. A conservative approach for initial sampling/work is taken to ensure worker protection. After data is collected, an industrial hygienist makes the judgement call on engineering controls, PPE, and administrative procedures/controls (Beryllium Operations Area designations or medical surveillance).
3. **Pantex** uses an additional action level (surface contamination in excess of 2.5 µg/100cm²) for the establishment of regulated areas.

14. & 15. For each operation identified in question 2, what engineering controls are currently in place? Are workers wearing respirators?

Summary Response:

Forty-four of the 64 operations identified in this survey, report the use of some kind of engineering control to reduce beryllium exposures. Some form of local exhaust ventilation (including laboratory hoods, fume hoods, and ventilated enclosures) is used for 23 of the 64 operations. Other controls include general room ventilation, HEPA vacuums, wet machining, remote operation, and various enclosures. Respirators are used regularly for 16 of the 64 operations and “sometimes” or “when action levels are reached” for 8 operations.

Detailed Response:

ORNL did not respond to this question; however, they did indicate that no employees have ongoing, direct exposure to beryllium and that workers are required to wear gloves for all

beryllium metal handling activities. "Not applicable" responses were submitted by ANL, K-25, and Pinellas.

Table 9 shows operations, facilities, controls, and respirator use.

Table 9.
Operations, Facilities, Controls and Respirator Use

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|--|-------------------|--|-------------------|
| Alloy Development | LANL ¹ | Local exhaust for equipment with potential to generate airborne particulate; HEPA vacuum cleaner | No |
| Applications | Y-12 | Local exhaust ventilation, lab hood | Yes |
| Baghouse | Y-12 | None reported | Yes |
| Beryllium Sputtering | LLNL | Under vacuum | No |
| Changing Filters | LLNL | None | Yes |
| | Y-12 | None | Yes |
| Cleaning, Machine | Y-12 | Inside enclosure: local exhaust ventilation and mineral oil; Outside enclosure: 409 and mineral oil | No |
| Cleaning, Parts | Y-12 | Full flow water | No |
| Cleanup of Detonated Shells | LLNL | None | Yes |
| Clothes Laundering | LANL ¹ | Water soluble laundry bags | No |
| Custodial Work | LANL ¹ | HEPA vacuum cleaners | Yes |
| Cutting Beryllium Foil | LBNL | None reported (workers wear gloves) | No |

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|--|-----------------------|--|--|
| Cutting/Grinding/ Polishing | SNL | Enclosed cabinet w/local exhaust and water wash (cutting); performed wet w/local exhaust ventilation (grinding/polishing) | No |
| Deburring | Allied | General room ventilation | No |
| D & D | Y-12 | None reported | Yes |
| | Rocky Flats | Local exhaust and glovebags | When action level is reached |
| | LANL ¹ | Local exhaust and controls similar to asbestos abatement industry (i.e., negative pressure, glove bags, HEPA vacuuming, low pressure steam cleaning) | For all initial work; thereafter, based on the operations and potential for particulate generation |
| Detonation of Shells | LLNL | None | No |
| Development | Y-12 | Local exhaust ventilation | Yes |
| Electrical Applications Using Cu/Be Conductors (handling, shearing, heat curing) | Fermilab ² | None | When action level is reached |
| Electron Beam Welding | LLNL | Glovebox | No |
| Hand-Sawing Beryllium Pipe | Fermilab ² | Not specified | When action level is reached |

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|--|-----------------------|---|---|
| Handling Beryllium Blocks | Fermilab ² | None | Normally, required when action level is reached |
| Handling Wastes | LLNL | Ventilated enclosure (sometimes) | Sometimes |
| Industrial Hygiene Sampling | LANL ¹ | N/A | N/A |
| Inspection | Y-12 | None | No |
| Ion implant, Bead Blasting, Metallization | SNL | Local exhaust ventilation | Yes |
| Joining and Coating | LANL ¹ | HEPA filtered exhaust of chambers; B-beam welder is lined with a removable liner for easy clean-up | Yes (for cleaning of chambers) |
| Laboratory | Y-12 | Lab hood | No |
| Laser Machining | LLNL | Enclosed, HEPA filter | No |
| Machining | Allied | Wet machining and/or local exhaust | No |
| | LLNL | Local exhaust | No |
| | LANL ¹ | Enclosures for some equipment, local high pressure exhaust for the tooling point; exhaust system equipped with HEPA filters | No |
| | SNL | Part submerged in water or in a liquid stream | No |
| | Y-12 | Enclosure, local ventilation, full flow coolant | No |

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|---|-------------------|--|--|
| Maintenance | LANL ¹ | Operations varied. Engineering controls depend upon operation | Yes |
| Maintenance of Contaminated Drains and Vacuum Lines | LLNL | None | Sometimes |
| Mechanical Properties | Y-12 | Local exhaust ventilation | No |
| Metallography | LANL ¹ | Hood | No |
| Metallurgical Stress Studies | LLNL | Ventilated enclosure | No |
| Pit Cleaning | Pantex | Ventilated enclosure w/ open arm ports | No |
| Plating | Allied | Local exhaust on tanks | No |
| Powder Operations | LANL ¹ | Currently not operational | Yes |
| Quality Evaluation | Y-12 | Walk in hood, local exhaust ventilation, No plexiglass isolation | No |
| Radiation Screening | LANL ¹ | N/A | N/A |
| Research - Beryllium Solutions | Hanford (PNNL) | Fume hoods | At levels which may cause health hazards |
| Research - Deposition of Gases onto a Substrate | SNL | Sealed chamber under a vacuum | No |
| Research - Transmission of Low Energy (X-ray) | Ames | Beryllium window not accessible or placed in plastic | No workers exposed |

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|--|-----------------------|---|------------------------------|
| Respirator Decontamination | LANL ¹ | Laboratory hood, containment of used respirators in plastic | No |
| Spectroscopic Analysis | Ames | Fume hood | No workers exposed |
| Storage of Beryllium Blocks | Fermilab ² | Metallic blocks kept dry and stored in tight containers | When action level is reached |
| Washing/Moving of Gravel from Shot Tables | LLNL | None | Yes |
| Waste Reclamation | Allied | General room ventilation | No |
| Weapon Assembly/ Disassembly | Pantex | None | No |
| | SNL | Beryllium components over-wrapped | No |
| Weapon Components Crushing | Pantex | Remote operation; clean residue w/ HEPA filter vacuum cleaner | No |
| Weapon Components Separation | Pantex | None | "As needed" |
| Weapon Components Shredding | Pantex | Portable local exhaust ventilation | Yes |
| Weapon Components Detonation | Pantex | Remote operation; clean residue w/ HEPA filter vacuum cleaner | No |
| Weapon Dismantlement | LLNL | Local exhaust of glovebox | Yes |
| | Pantex | None | No |

| Operation/ Process/ Equipment | Facility | Control | Respirator |
|--|-----------------|---------------------------------------|-----------------------------------|
| Weapon Dismantlement/ Disassembly | Pantex | Local exhaust ventilation | No |
| Weapon Integrity Testing | LLNL | Local exhaust or ventilated enclosure | Yes |
| Weapon Shield Installation and Removal | Pantex | None (not considered feasible) | Yes, (until exposure level known) |
| Weapons Materials Management | Y-12 | None | No |
| Welding | Allied | Welding enclosures w/ local exhaust | No |

1. LANL notes that they consider wet methods to be work practices and therefore do not identify wet methods as a control in their response.
2. Fermilab supplemented their response concerning engineering controls indicating that engineering controls are generally impractical since operations are brief, sporadic, conducted in various locations, and result in negligible exposures. Fermilab further indicated that “wet methods, enclosure, and/or local HEPA collection systems would be used if it ever became necessary to control exposures.”

16. Are the operations identified in question 2 projected to be continued in the future?

Summary Response:

The operations identified in question 2 are expected to continue at Allied, Fermilab (at least the handling and storage operations), Hanford, LLNL, LANL, Pantex (all but the weapon dismantlement operations), Rocky Flats, SNL, and Y-12 (however, the future of two operations, applications and D & D, is unknown).

Detailed Response:

"**Yes**" responses were provided or suggested by Allied; Fermilab (at least the handling and storage operations); Hanford; LLNL; LANL; Pantex (all but the weapon dismantlement operation); Rocky Flats; SNL; and Y-12 (however, the future of two operations, applications and D & D, is unknown).

"**Not applicable**" responses were submitted by Ames, ANL, K-25, and Pinellas. LBNL and ORNL did not respond to this question.

17. Is access to beryllium areas restricted at the present time?

Summary Response:

Allied, Fermilab, Hanford, K-25, LANL, Rocky Flats, SNL, and Y-12 reported controlling access to some (based on exposure potential) or all beryllium operations or work areas. LLNL and Pantex indicated that none of their current beryllium operations met their criteria for establishing controlled access areas.

Detailed Response:

"**Yes**" responses were submitted by Allied (for operations that present potential exposure hazards); Fermilab; K-25; LANL; Rocky Flats; SNL (for the cutting/grinding/polishing, machining, and weapon assembly/disassembly operations only); and Y-12.

Several facilities supplemented their "**yes**" responses as follows:

- Fermilab: Indicated that access is limited to operations which are likely to result in measurable exposures: their response suggests that beryllium storage areas are the only ongoing controlled access beryllium areas.
- K-25: Provided further clarification of their "yes" response indicating that access to their contaminated facility was restricted not only because of beryllium contamination but also because of the presence of other hazardous and radiological material.

Y-12: Indicated that access to "regulated beryllium areas" was restricted, however, it is not clear from their response, what constitutes a "regulated beryllium area."

"**Not applicable**" responses were submitted by Ames, ANL, and Pinellas.

Other responses included:

Hanford: Indicated that there was no need to restrict access to locations storing or using beryllium and indicated that research activities involving beryllium were conducted in laboratories, all of which were restricted access.

LLNL: Indicated that they had no defined beryllium areas because airborne levels were not significant.

Pantex: Indicated that none of their current beryllium operations met their criteria for beryllium regulated areas (see response to question 13 above for Pantex's criteria). Pantex indicated that Firing Site 23 is contaminated with beryllium and radioactive materials and access is controlled, but that no entries had been made into this facility since 1994.

LBNL and ORNL did not respond to this question.

18. If yes, who is allowed to enter a restricted area?

Summary Response:

Access controls for established beryllium areas vary from site to site. Responders, however, reported the use of several common prerequisites necessary for entry into controlled beryllium areas. These prerequisites include proper training (Allied, Fermilab, LANL, and Pantex), proper authorization (Allied, LBNL, Rocky Flats, SNL, and Y-12), and a need to enter to perform assigned work duties (Fermilab, Hanford, LBNL, LANL, Rocky Flats, SNL, and Y-12).

Detailed Response:

Allied: Properly trained (carcinogen training) personnel with authorization from first line management.

Fermilab: Properly trained (or closely supervised) personnel who need to participate in the operation.

Hanford: Access to laboratories is restricted to research staff conducting research.

LBNL: The facility operator or other personnel with the approval of the facility operator.

LANL: Authorized employees with required training and medical surveillance and with the need for access to perform their work. Line management reviews and authorizes individuals to enter the area.

Pantex: Appropriately trained (HAZCOM, radiation worker, and respirator training) personnel with a need to enter.

Rocky Flats: Employees performing work and other personnel specifically permitted to enter such areas.

SNL: Only the workers doing the work.

Y-12: Authorized personnel and personnel with a need to enter.

"**Not applicable**" responses were submitted by Ames, ANL, LLNL, and Pinellas.

LBNL and ORNL did not respond to this question.

19. Are clean-up workers exposed to beryllium in D&D operations?

Summary Response:

Clean-up workers at LANL, Rocky Flats, and Y-12 are potentially exposed to beryllium during D&D operations. **Note:** Y-12 had only one D&D operation with the potential for beryllium exposure.

Detailed Response:

"**Yes**" responses submitted or implied by LANL, Rocky Flats, and Y-12.

LANL and Y-12 qualified their “**yes**” responses as follows:

LANL: Employees who conduct D&D operations in three rooms of a building currently being renovated for the new Beryllium Technology Facility and who work on the ventilation system that exhausted this area, are potentially exposed to airborne beryllium particulate.

Y-12: Y-12 had one D & D operation in April of 1996, involving barrels of dirt with low levels of beryllium contamination.

"**No**" responses were provided by SNL.

"**Not applicable**" or “**no current D & D operations**” responses were submitted or implied by Allied, Ames, ANL, Fermilab, Hanford (PNNL), K-25, LBNL, LLNL, ORNL, Pantex, and Pinellas.

20. Do clean-up workers exposed to beryllium in D&D operations "suit up" with full protective gear when they perform these operations?

Summary Response:

At Rocky Flats clean-up workers potentially exposed to beryllium “suit up” with full protective gear when they perform D&D operations. In Y-12’s one D & D operation, personnel wore a full face respirator with HEPA filters, tyvek suits, gloves, and shoe covers. LANL employees conducting D&D operations are required to wear company provided modesty garments, coveralls, gloves, site-specific shoes, and booties. In addition, LANL requires the use of full-face respirators for operations that have the potential to generate airborne beryllium particulates.

Detailed Response:

Rocky Flats: Yes, typically.

Y-12: In Y-12's one D & D operation, personnel wore a full face respirator with HEPA filters, tyvek suits, gloves and shoe covers.

LANL: PPE worn is commensurate with the risk of potential exposure or contamination. D&D operations require employees to wear company provided modesty garments, coveralls, gloves, site-specific shoes, and booties. In addition, full-face respirators are required for operations that have the potential to generate airborne beryllium particulates. Employees are required to take a shower at the end of the day.

"**Not applicable**" responses were submitted or implied by Allied, Ames, ANL, Fermilab, Hanford (PNNL), K-25, LBNL, LLNL, ORNL, Pantex, Pinellas, and SNL.

21. Do they wear respirators at all times on the job?

Summary Response:

Y-12 workers wore respirators during their one D&D operation. LANL and Rocky Flats determine the need for respiratory protection based on the potential for exposure.

Detailed Response:

A "**yes**" response was provided by Y-12.

A **qualified yes** response was provided by LANL. LANL indicated that respiratory protection is worn for all initial work. Breathing zone sampling is conducted for initial work. Some operations require respiratory protection such as removal of the exhaust ventilation system. Other operations do not require respiratory protection. Therefore, respiratory protection is based on the operation and potential for generating airborne particulate.

A "**no**" response was provided by Rocky Flats (respirators worn based on potential for exposure).

"**Not applicable**" responses were submitted or implied by Allied, Ames, ANL, Fermilab, Hanford (PNNL), K-25, LBNL, LLNL, ORNL, Pantex, Pinellas, and SNL.

22. Do you plan to use beryllium in any operation or process in the future?

Summary Response:

Eleven of the sites surveyed (Allied, Ames, Fermilab, Hanford, LBNL, LLNL, LANL, Pantex, Rocky Flats, SNL, and Y-12) plan to use beryllium in future operations and/or processes; ANL does not. K-25 and Pinellas considered this question “not applicable.”

Detailed Response:

“Yes” responses were provided by Allied, Ames, Fermilab, Hanford, LBNL, LLNL, LANL, Pantex, Rocky Flats, SNL, and Y-12.

A “no” response was provided by ANL.

“Not applicable” responses were submitted by K-25, and Pinellas.

ORNL did not respond to this question.

23. If yes, in what operations or processes will beryllium be used?

Summary Response:

Allied, Y-12, and SNL will use beryllium in all current operations. Ames will use it for a spectroscopic analysis operation, and a research operation involving the transmission of low energy. Fermilab will continue operations involving storage and bulk handling of metallic beryllium blocks. Hanford will use beryllium for research activities. LBNL will use it for materials science research. LLNL will use it in current operations and in the proposed contained firing facility and potentially in the National Ignition Facility. LANL will use it at the new Beryllium Technology Facility. Pantex’s ongoing weapon programs and weapon components demilitarization and sanitization operations and Rocky Flats’ repackaging of beryllium parts and D & D work will also continue to involve the potential for beryllium exposures.

Detailed Response:

Allied: In current operations.

Ames: A spectroscopic analysis operation, and a research operation involving the transmission of low energy (Be is a component of X-ray tube windows).

Fermilab: At least storage and bulk handling of metallic beryllium blocks.

Hanford: Research activities involving beryllium.

LBNL: Materials science research: evaporation of 1 gram of beryllium per year in a closed vacuum chamber. Vaporized material will recondense within the chamber.

LLNL: In current operations and in the proposed contained firing facility to be built at Site 300 and potentially in the National Ignition Facility.

LANL: The new Beryllium Technology Facility will have a few new operations to LANL. They include foundry and gas atomization operations. There are also some research operations that are expected to be conducted which include destructive testing of small beryllium parts, chemical vapor deposition, and wire-drawn swaging.

Pantex: Ongoing weapon programs and weapon components demilitarization and sanitization operations.

Rocky Flats: Repackaging of beryllium parts and D & D work.

SNL: In current operations.

Y-12: In all but two current operations (the future of applications and D & D is unknown).

"Not applicable" responses were submitted by ANL, K-25, and Pinellas.

ORNL did not respond to this question.